

**REMARKS**

Claims 1 through 25 are pending in this application. The specification has been amended to address a manifest typographical oversight, and claims 8 and 9 amended consistent with the Examiner's observations. In addition, new claims 20 through 25 have been added. Care has been exercised to avoid the introduction of new matter. Indeed, adequate descriptive support for the present Amendment should be apparent throughout the originally filed disclosure.

Applicants submit that the present Amendment does not generate any new matter issue.

**Claim Objections**

The Examiner objected to claims 8 and 9 identifying perceived typographical oversights. In response, claims 8 and 9 have been amended to address the perceived informalities mentioned by the Examiner, thereby overcoming the stated bases for the claim objections. The Examiner's perspicacity is appreciated. Applicants, therefore, solicit withdrawal of the claim objections.

**Claims 1 and 10 were rejected under 35 U.S.C. § 102 for lack of novelty as evidenced by Nogami et al.**

In the statement of the rejection the Examiner asserted that Nogami et al. disclose a semiconductor device corresponding to that claimed. In so doing the Examiner referred to Fig. 1 identifying an inlaid copper interconnect by reference character 10, and asserting the composite capping layer thereon corresponds to that of the claimed invention. This rejection is traversed as factually inaccurate.

The factual determination of lack of novelty under 35 U.S.C. § 102 requires the identical disclosure in a single reference of each element of a claimed invention, such that the identically

claimed invention is placed into the recognized possession of one having ordinary skill in the art.

*Dayco Prods., Inc. v. Total Containment, Inc.* 329 F.3d 1358, 66 USPQ2d 1801 (*Fed. Cir.* 2003); *Crown Operations International Ltd. v. Solutia Inc.*, 289 F.3d 1367, 62 USPQ2d 1917 (*Fed. Cir.* 2002). In imposing a rejection under 35 U.S.C. § 102, the Examiner is required to specifically identify wherein an applied reference is perceived to identically disclose each and every feature of a claimed invention. *In re Rijckaert*, 9 F.3d 1531, 28 USPQ2d 1955 (*Fed. Cir.* 1993); *Lindemann Maschinenfabrik GMBH v. American Hoist & Derrick Co.*, 730 F.2d 1452, 221 USPQ 481 (*Fed. Cir.* 1984). That burden has not been discharged. Indeed, there are significant differences between the claimed semiconductor device and method and those disclosed by Nogami et al. that scotch the factual determination that Nogami et al. disclose a semiconductor device and method identically corresponding to those claimed.

Specifically, the semiconductor device defined in independent claim 1, and produced by the method defined in claim 10, comprises copper inlaid in a first dielectric layer and a composite capping layer thereon. That composite capping layer comprises a first layer of a β-Ta on an upper surface of the inlaid copper, a layer of tantalum nitride on the β-Ta layer, and a layer of α-Ta on the layer of tantalum nitride. No such structure is disclosed or suggested by Nogami et al.

The Examiner identified reference character 10 as a copper interconnect inlaid in a dielectric layer 12. It should be noted that Nogami et al. are concerned with an interconnect **between a Cu feature and an Al feature**. To achieve that objective, a four layer barrier structure composite is provided for linking the Cu and Al features such that the Cu and Al features are electrically connected without Kirkendal voiding, reduced electromigration, reduced

resistivity and high resistance to diffusion of both Cu and Al. The layers must be formed in a specific sequence.

When the Examiner says that reference character 10 denotes copper, then the layer in contact with copper is **not**, repeat **not**, element 13 asserted by the Examiner in the ultimate sentence on page 2 of the April 21, 2005 Office Action. Rather, the layer in contact with Cu is identified as layer 16 which need not even be tantalum, because it could be tantalum nitride. Further, the Examiner has not identified any factual basis upon which to determine that the layer in contact with Cu is **necessarily**  $\beta$ -Ta. This is because, as previously pointed out it need not even be Ta. Secondly, the Examiner has not factually established that the layer of Ta is deposited under conditions which necessarily generate the  $\beta$ -Ta form.

Further, in accordance with the claimed invention, a layer of  $\alpha$ -Ta is deposited on tantalum nitride. No such layer is disclosed or suggested by Nogami et al. In fact, layer 13 has Al diffused therein. There is no apparent factual basis of record, and the Examiner has not espoused any theory, to support the conclusion that layer 13 is **necessarily**  $\alpha$ -Ta. As the Examiner should be aware, inherency requires **certainty**, not speculation. *Crown Operations International Ltd. v. Solutia Inc.*, *supra*; *Finnegan Corp. v. ITC*, 180 F.3d 1354, 51 USPQ2d 1001 (Fed. Cir. 1999); *In re Robertson*, 169 F.3d 743, 49 USPQ2d 1949 (Fed. Cir. 1999); *Electro Medical Systems S.A. v. Cooper Life Sciences, Inc.*, 34 F.3d 1048, 32 USPQ2d 1017 (Fed. Cir. 1994); *In re Rijckaert*, *supra*; *Continental Can Co. USA, Inc. v. Monsanto Co.*, 948 F.2d 1264, 20 USPQ2d 1746 (Fed. Cir. 1991); *W. L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983).

The above argued differences between the claimed semiconductor device and method and those disclosed by Nogami et al. undermine the factual determination that Nogami et al. disclose

a semiconductor device and method corresponding to those claimed. *Minnesota Mining & Manufacturing Co. v. Johnson & Johnson Orthopaedics Inc.*, 976 F.2d 1559, 24 USPQ2d 1321 (Fed. Cir. 1992); *Kloster Speedsteel AB v. Crucible Inc.*, 793 F.2d 1565, 230 USPQ 81 (Fed. Cir. 1986). Applicants, therefore, submit that the imposed rejection of claims 1 and 10 under 35 U.S.C. § 102 for lack of novelty as evidenced by Nogami et al. is not factually viable and, hence, solicit withdrawal thereof.

**Claims 4 and 14 were rejected under 35 U.S.C. § 103 for obviousness predicated upon Nogami.**

In the statement of the rejection the Examiner admitted that Nogami et al. do not disclose an  $\alpha$ -Ta layer having a thickness of 200 to 500 $\text{\AA}$ . The Examiner asserted that Nogami et al. disclose an  $\alpha$ -Ta layer of 10 to 150 $\text{\AA}$ . The Examiner, nevertheless concluded that one having ordinary skill in the art would have found the claimed invention obvious. This rejection is traversed.

Firstly, it is not apparent and the Examiner did not identify wherein Nogami et al. disclose an  $\alpha$ -Ta layer to begin with. Further, in accordance with the present invention, an  $\alpha$ -Ta layer is formed on a tantalum nitride layer which in turn is formed on a  $\beta$ -Ta layer which, in turn, is on inlaid Cu. No such structure is even disclosed by Nogami et al.

Moreover, the range for the  $\alpha$ -Ta layer begins at 200 $\text{\AA}$ ; whereas the maximum thickness disclosed by Nogami et al. is 150 $\text{\AA}$ , and that is not even for an  $\alpha$ -Ta layer. While one having ordinary skill in the art may have been motivated to optimize the thickness of a layer disclosed by Nogami et al. between the disclosed minimum of 10 $\text{\AA}$  and the disclosed maximum of 150 $\text{\AA}$ , there is **no** apparent factual basis upon which to predicate the conclusion of one having ordinary

skill in the art would have been realistically motivated to go **outside** of the range disclosed by Nogami et al. In this respect the Examiner's attention is invited to *In re Sebek*, 465 F.2d 904, 175 USPQ 93 (CCPA 1972).

Further, claim 4 depends from claim 1 and claim 14 depends from claim 10. Applicants incorporate herein the arguments previously advanced in traversing the imposed rejection of claims 1 and 10 under 35 U.S.C. § 102 for lack of novelty as evidenced by Nogami et al. The Examiner's additional comments in rejecting claims 4 and 14 do not cure the previously argued deficiencies of Nogami et al.

Based upon the foregoing Applicants submit that the imposed rejection of claims 4 and 14 under 35 U.S.C. § 103 for obviousness predicated upon Nogami et al. is not factually or legally viable and, hence, solicit withdrawal thereof.

**Claims 2, 3, 5, 11, 12 and 13 were rejected under 35 U.S.C. § 103 for obviousness predicated upon Nogami et al. in view of Wang et al.**

In the statement of the rejection the Examiner admitted that Nogami et al. do not disclose the formation of a capping layer in a recess in inlaid copper. The Examiner, nevertheless, concluded the claimed invention would have been obvious in view of Wang et al. This rejection is traversed.

Firstly, claims 2, 3 and 5 depend from independent claim 1, and claims 11 through 13 depend from independent claim 10. Applicants incorporate herein the arguments previously advanced in traversing the imposed rejection of claims 1 and 10 under 35 U.S.C. § 102 for lack of novelty as evidenced by Nogami et al. The additional reference to Wang et al. does not cure the previously argued deficiencies of Nogami et al. Accordingly, even if the applied references

are combined as suggested by the Examiner, and Applicants do **not** agree that the requisite fact-based motivation has been established for reasons set forth *infra*, the claimed invention would not result. *Uniroyal, Inc. v. Rudkin-Wiley Corp.*, 837 F.2d 1044, 5 USPQ2d 1434 (Fed. Cir. 1988).

**There is no motivation.**

In order to establish the requisite realistic motivation, the Examiner must make clear and particular factual findings as to a specific understanding or specific technological principle and, based upon such facts, explain **why** one having ordinary skill in the art would have been realistically motivated to modify particular prior art, in this case, the particular semiconductor device and method disclosed by Nogami et al., to arrive at the claimed inventions. *In re Lee*, 237 F.3d 1338, 61 USPQ2d 1430 (Fed. Cir. 2002); *Ecolochem Inc. v. Southern California Edison, Co.* 227 F.3d 1361, 56 USPQ2d 1065 (Fed. Cir. 2000); *In re Kotzab*, 217 F.3d 1365, 55 USPQ 1313 (Fed. Cir. 2000); *In re Dembiczaik*, 175 F.3d 994, 50 USPQ2d 1614 (Fed. Cir. 1999); *In re Rouffet*, 149 F.3d 1350, 47 USPQ2d 1453 (Fed. Cir. 1998).

In applying the above legal tenets to the exigencies of this case, Applicants submit that a *prima facie* basis to deny patentability to a claimed invention has not been established for lack of the requisite realistic motivation. Specifically, and as previously argued, Nogami et al. do **not** relate to forming a copper interconnect in electrical connection with another copper interconnect. The entire structure disclosed by Nogami et al. is specifically designed for electrically connecting a Cu feature with an Al feature. See, for example, column 4 of Nogami et al., lines 26 *et seq.* But the structure disclosed by Wang et al. serves a different purpose. Specifically, the diffusion barrier disclosed by Wang et al. is formed in a recess of inlaid Cu so that an

encapsulating layer 240 (Fig. 8), for example, can be provided without lateral drift of material from the interconnect along the bottom of the encapsulating layer. See, for example, column 2 of Wang et al., lines 43 through 48.

Since Nogami et al. do not seek to encapsulate Cu within an encapsulating layer, and since Nogami et al. are not apparently concerned with lateral drift from the bottom of any encapsulating layer, but rather seek to connect a Cu feature to an Al feature, it is **not** apparent and the Examiner did **not** explain **why** one having ordinary skill in the art would have been realistically impelled by Wang et al. to imbed the particular interconnect disclosed by Nogami et al. within a copper layer within a recess of a copper feature, bearing in mind that the composite structure is designed to electrically connect a Cu feature to an Al feature. *In re: Rouffet supra*. Appellants submit that there is **no factual basis** of record upon which to conclude that one having ordinary skill in the art would have been realistically impelled by Wang et al., who seek to prevent lateral drift of material from the interconnect along the bottom of an encapsulating layer, to imbed the four layer composite connection structure disclosed by Nogami et al. within a recess of a Cu feature, particularly since Nogami et al. are not concerned with an encapsulating layer or material drifting along the bottom of any encapsulating layer. *In re: Rouffet supra*. Applicants, therefore, submit that the Examiner did not establish the requisite fact-based motivation.

Based upon the foregoing Applicants submit that the imposed rejection of claims 2, 3, 5, 11, 12 and 13 under 35 U.S.C. § 103 for obviousness predicated upon Nogami et al. in view of Wang et al. is not factually or legally viable and, hence, solicit withdrawal thereof.

**Claims 6 through 9 and 16 through 19 were rejected under 35 U.S.C. § 103 for obviousness predicated upon Nogami et al in view of Wang et al. and Schmidbauer et al.**

In the statement of rejection the Examiner asserted that even if Nogami et al. and Wang et al. are combined, the resulting structure and method would not involve a second dielectric layer over the first dielectric layer and a copper interconnect inlaid in the opening in the second dielectric layer in electrical contact with the surface of an  $\alpha$ -Ta layer. The Examiner turns to Schmidbauer et al. and then concludes that the claimed invention would have been obvious. This rejection is traversed. Applicants submit that the Examiner did not establish the requisite factual basis or realistic fact-based motivation to support a *prima facie* case of obviousness.

Firstly, claim 6 through 9 depend from independent claim 1, and claims 16 through 19 depend from independent claim 10. Applicants incorporate here the arguments previously advanced in traversing the imposed rejection of claims 1 and 10 under 35 U.S.C. § 102 for lack of novelty as evidenced by Nogami et al. The additional references to Wang et al. and Schmidbauer et al. do not cure the previously argued deficiencies of Nogami et al. Accordingly, even if the applied references are combined as suggested by the Examiner, and Applicants certainly do not agree that the requisite fact-based motivation has been established for reasons set forth *infra*, the claimed invention would **not** result. *Uniroyal v. Rudkin-Wiley supra*.

As previously argued, one having ordinary skill in the art would not have been motivated to modify the structure disclosed by Nogami et al. by forming the composite interconnect structure within a recess of a Cu feature in view of Wang et al., because Wang et al. are addressed to a structure wherein a Cu feature is encapsulated and a diffusion barrier layer is formed within a recess to prevent lateral drift of material from the interconnect along the bottom

of the encapsulating layer. But Nogami et al. seek to electrically connect a Cu feature to an Al feature.

The Examiner's application of Schmidbauer et al. flies in the face of the primary reference to Nogami et al. While Schmidbauer et al. may disclose a Cu interconnect in electrical contact with another Cu feature. Nogami et al. do **not** electrically connect a Cu feature to a Cu feature. Rather, Nogami et al. electrically connect a Cu feature to an Al feature. If the structure disclosed by Nogami et al. is modified to electrically connect a Cu feature to a Cu feature, then the entire composite structure employed by Nogami et al. is unnecessary because it is specifically designed to electrically connect a Cu feature to an Al feature. Just because Schmidbauer et al. connect a Cu feature to a Cu feature, does not mean that one having ordinary skill in the art would have been realistically motivated to undue the entire structure disclosed by Nogami et al. There is simply no fact-based reason why one having ordinary skill in the art would have dramatically modified and destroyed the entire invention of Nogami et al. by electrically connecting a Cu feature to a Cu feature. In this respect Applicants would stress that one having ordinary skill in the art cannot be presumed motivated to modify a reference, in this case, Nogami et al., in a manner completely inconsistent with the disclosed objective. See, for example, *In re Fritch*, 972 F.2d 1260, 23 USPQ2d 1780 (Fed. Cir. 1992); *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984); *In re Schulpen*, 390 F.2d 1009, 157 USPQ 52 (CCPA 1968).

Moreover, Applicants would separately and strenuously argue the patentability of claims 7 and 17. This is because in accordance with Nogami et al., the outermost layer of the composite contains aluminum, and it has not been factually shown to be  $\alpha$ -Ta. Further, there is no factual basis upon which to predicate the determination that a layer of Ta deposited on a layer of  $\alpha$ -Ta

containing Al would necessarily result in a formation of an  $\alpha$ -Ta layer. Again, inherency requires **certainty not speculation**. *Crown Operations International Ltd. v. Solutia Inc.*, *supra*; *In re Finnegan*, *supra*, *In re Robertson*, *supra*; *Electro Medical Systems S.A. v. Cooper Life Sciences, Inc.*, *supra*; *In re Rijckaert*, *supra*, *Continental Can Co. USA, Inc. v. Monsanto Co.*, *supra*, *W. L. Gore & Associates, Inc. v. Garlock, Inc.*, *supra*.

Based upon the foregoing Applicants submit that the imposed rejection of claims 6 through 9 and 16 through 19 under 35 U.S.C. § 103 for obviousness predicated upon Nogami et al. in view of Wang et al. and Schmidbauer et al. is not factually or legally viable and, hence, solicit withdrawal thereof.

**Claim 15 was rejected under 35 U.S.C. § 103 for obviousness predicated upon Nogami et al. in view of Wang et al. and Lopatin et al.**

This rejection is traversed. Specifically, claim 15 depends from independent claim 10. Applicants incorporate herein the arguments previously advanced in traversing the imposed rejection of claim 10 under 35 U.S.C. § 102 for lack of novelty as evidenced by Nogami et al. The additional references to Wang et al. and Lopatin et al. do not cure the previously argued deficiencies of Nogami et al. Accordingly, even if the applied references are combined as suggested by the Examiner, and again Applicants do not agree that the fact-based motivation has been established, the claimed invention would not result. *Uniroyal, Inc. v. Rudkin-Wiley Corp.*, *supra*.

Applicants, therefore, submit that the imposed rejection of claim 15 under 35 U.S.C. § 103 for obviousness predicated upon Nogami et al. in view of Wang et al. and Lopatin et al. is not factually or legally viable and, hence, solicit withdrawal thereof.

**New Claims 20 through 25.**

New claims 20 through 25 are free of the applied prior art by virtue of their dependence upon either independent claim 1 or independent claim 10, the patentability of which has been previously argued. Further, Applicants separately argue the patentability of claims 20 through 25. Specifically, the primary reference to Nogami et al. discloses what must be a four layer structure. Indeed, the composite four layer structure is strategically designed (column 5, lines 21 through 26) and, hence, is excluded from claims 20, 21, 23 and 24. As previously argued, one having ordinary skill in the art would not have been motivated to depart from the teachings of Nogami et al. to form an  $\alpha$ -Ta layer having a minimum thickness of 200 $\text{\AA}$ , because Nogami et al. do not even disclose the formation of an  $\alpha$ -Ta layer and set a maximum thickness of 200 $\text{\AA}$ .

Based upon the foregoing it should be apparent that the imposed objection and rejections have been overcome and that all pending claims are in condition for immediate allowance. Favorable consideration is, therefore, solicited.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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